A Case Study of eBay UTF-8 Database Migration

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What is the difficulty in migrating from ISO Latin 1 to UTF-8?

eBay: The World's Online Marketplace

An online trading platform where everyone can trade almost anything from anywhere

- A global presence in 33 international markets
- 203 million registered users
- $44.3 billion in annualized gross merchandise volume (value of goods sold)
- 724,000 small business and individuals in U.S. use eBay as a primary or secondary sales channel
- 36,000 Developers via eBay API

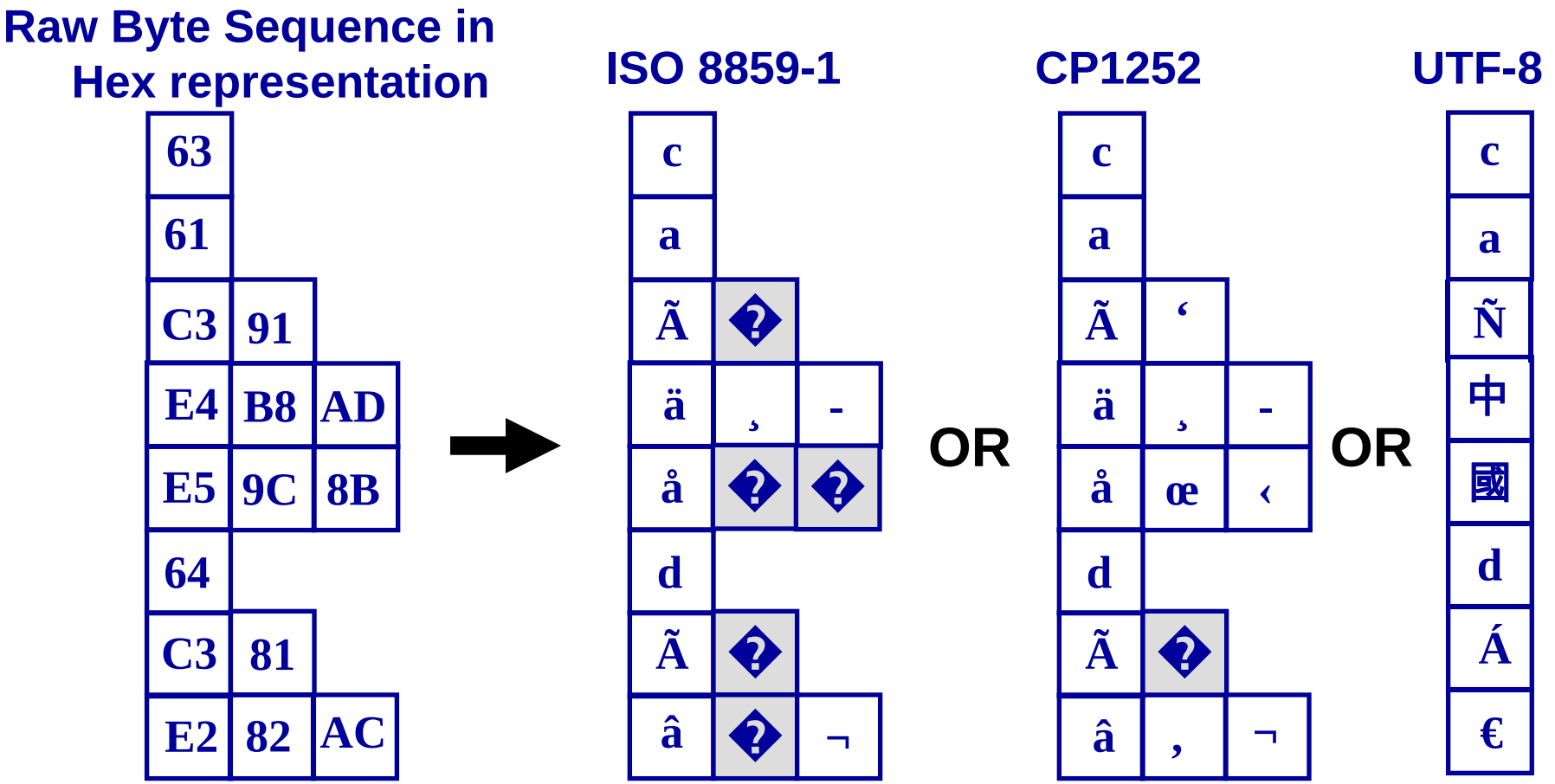
Data as of Q2 2006.

Agenda

- **Reasons for UTF-8 Migration**
- **Challenges of UTF-8 Migration**
- **Approaches to UTF-8 Migration**
- **Lessons Learned**

Reasons
for
UTF-8 Migration

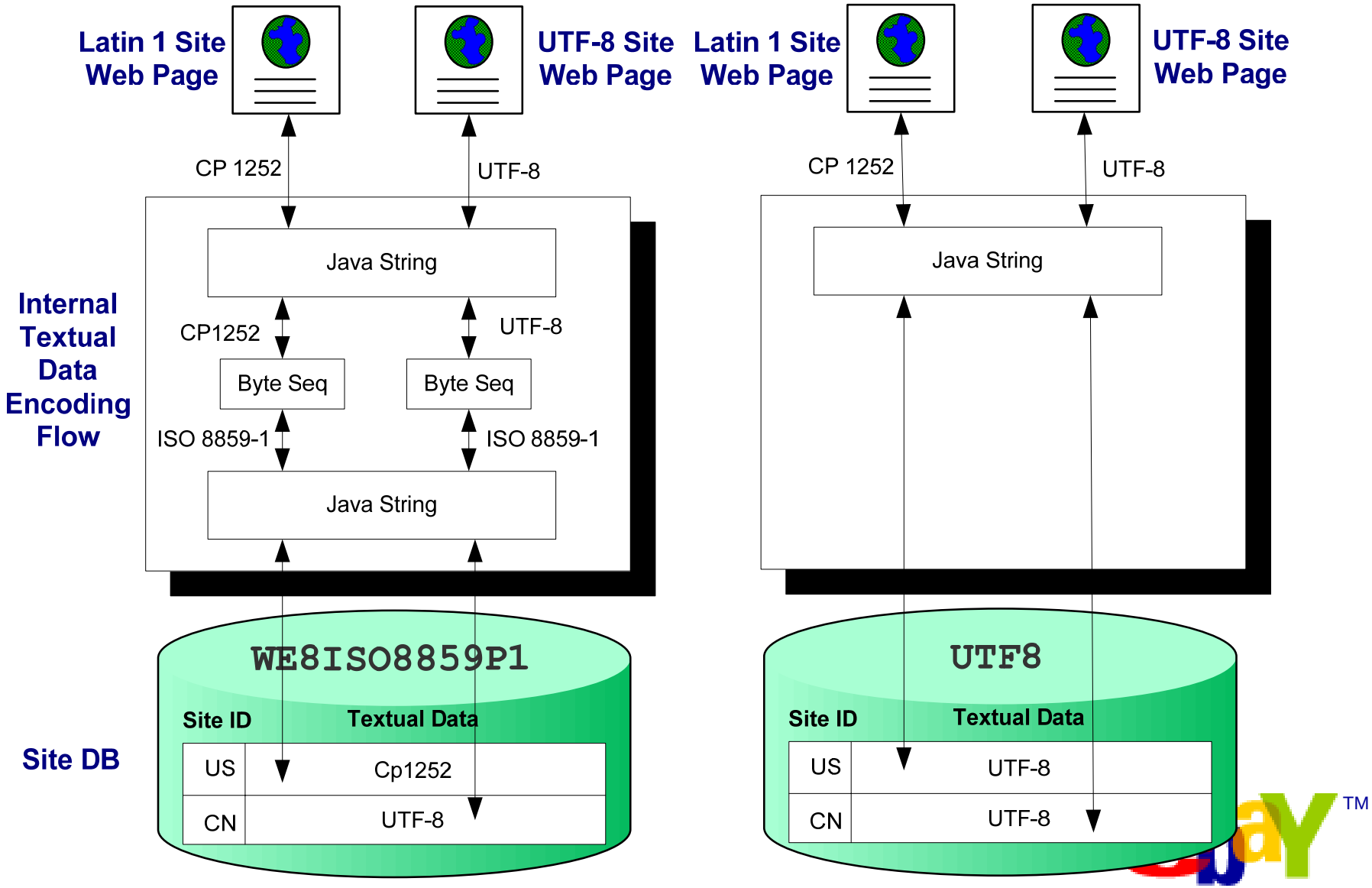
Ambiguity in Textual Data Representation



eBay Marketplace Textual Data Encoding Model

- **eBay Marketplace supports both Latin 1 and UTF-8 sites on a single platform:**
  - **Latin 1 Sites:** US, CA, UK, AU, FR, DE, IT, BE (nl), BE (fr), NL, ES, CH, AT, IE, NZ
  - **UTF-8 Sites:** TW, IN, CN, HK, MY, PH, PL, SG, SE
- **Textual data for all sites are stored in the same set of tables and DB hosts**
- **A combination of ISO Latin 1 and UTF-8 DB hosts**
  - **ISO Latin 1 DB host:**
    - **Latin 1 Site records:** Encoded in Cp1252
    - **UTF-8 Site records:** Encoded in UTF-8
  - **UTF-8 DB host:**
    - **All Site records:** Encoded in UTF-8

Textual Data Encoding Flow



Issues with Textual Data Encoding Model

- **Cross-Border Trade Impediments**
- **Increased code complexity and developmental costs to support mixed textual data encoding model**
- **Increased 3rd Party integration costs to implement eBay textual data encoding model**
- **Textual data encoding model not supported by Oracle**

Challenges
of
UTF-8 Migration

Summary of Challenges

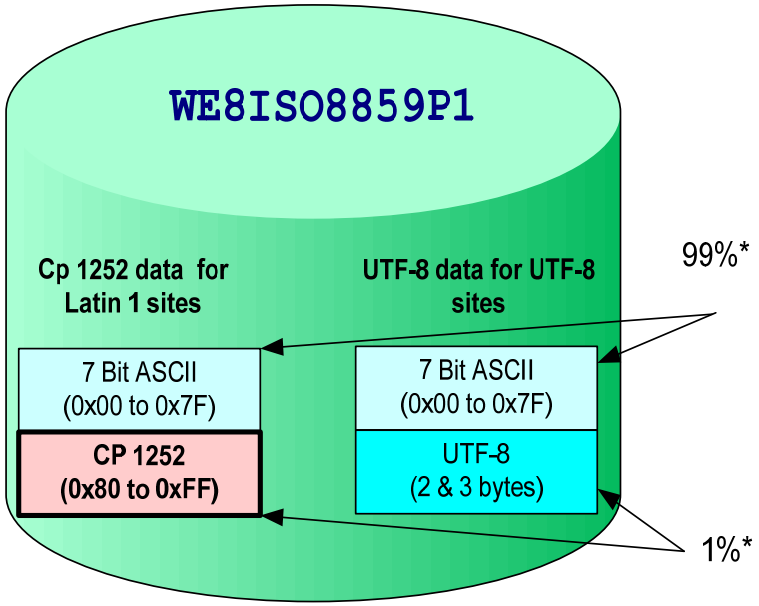
- **Stringent Availability**
  - **Site Uptime Requirement:** **99.94%**
- **Magnitude of Data**
  - **Total Site DB Hosts:** **~160**
  - **Total Active DB Tables:** **~2000**
  - **Total DB Storage Usage:** **~200TB**
  - **Total Redo Log Generation:** **~2TB/day**
- **Extreme Usage**
  - **Peak time SQL Execution:** **~462K/sec**
  - **Avg. time for SELECT:** **~7ms**
  - **Avg. time for INSERT/UPDATE:** **~15ms**
  - **Total Application Servers:** **~5K**
- **Frequency of Change**
  - **Release Cycle:** **Every two weeks**

Notes: DB related metrics are for Primary site facing DB only. This doesn't including non site facing functions such as DR, Archive, DW etc.

Approach
to
UTF-8 Migration

How Big was the Problem?

- **Scanning DB hosts with Oracle CSSCAN**
- **Identify different types of textual data encoding**
  - **7 bit ASCII** (0x0 to 0x7F): No conversion. Same value as-is in UTF-8
  - **8 bit Cp1252** (0x80 to 0xFF): Converted into 2 bytes or 3 bytes for UTF-8.
  - **UTF-8** (2bytes or 3 bytes): No conversion. Same value as-is for UTF-8

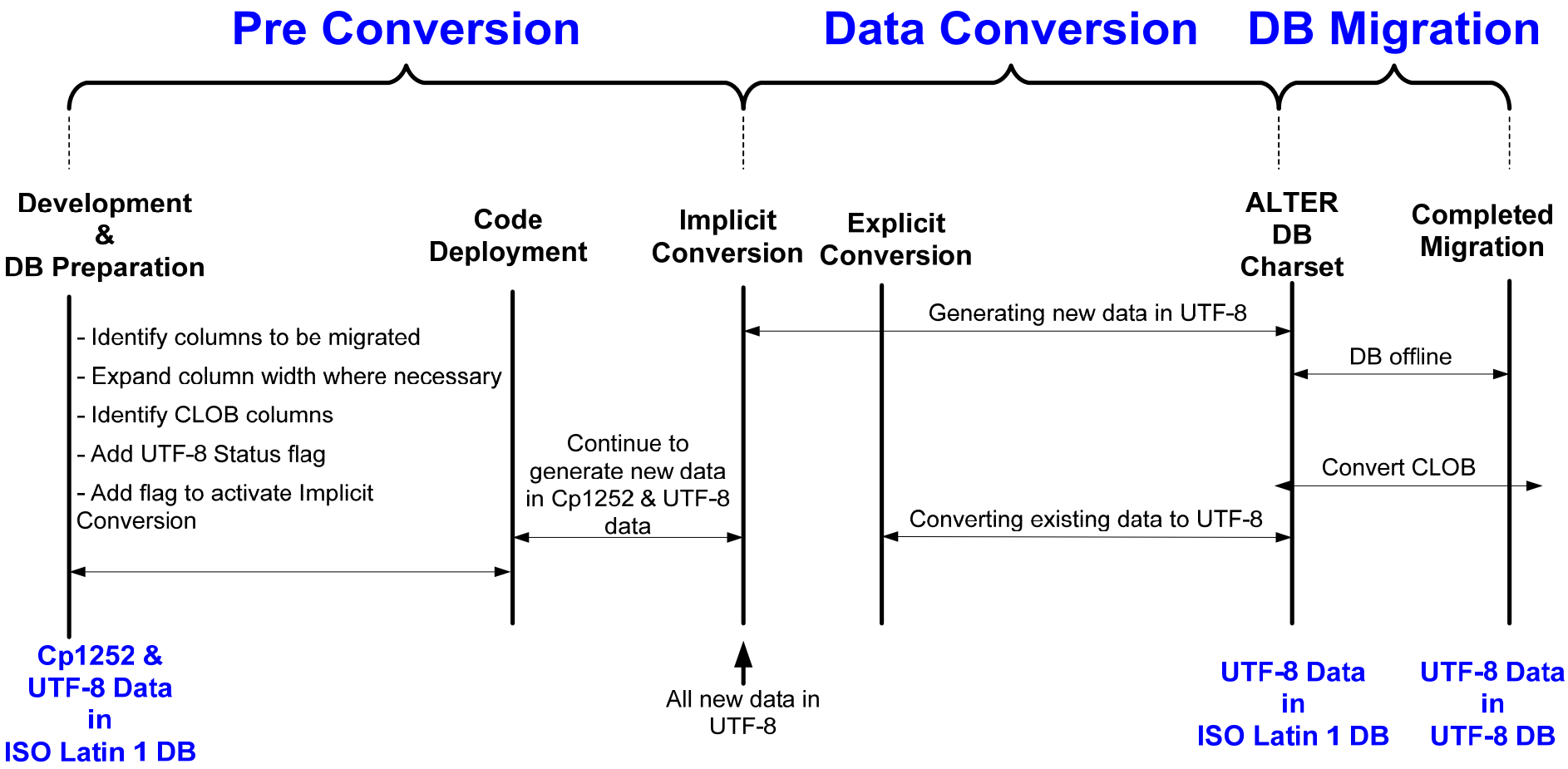


* Data was gathered in Oct 2003

Approaches

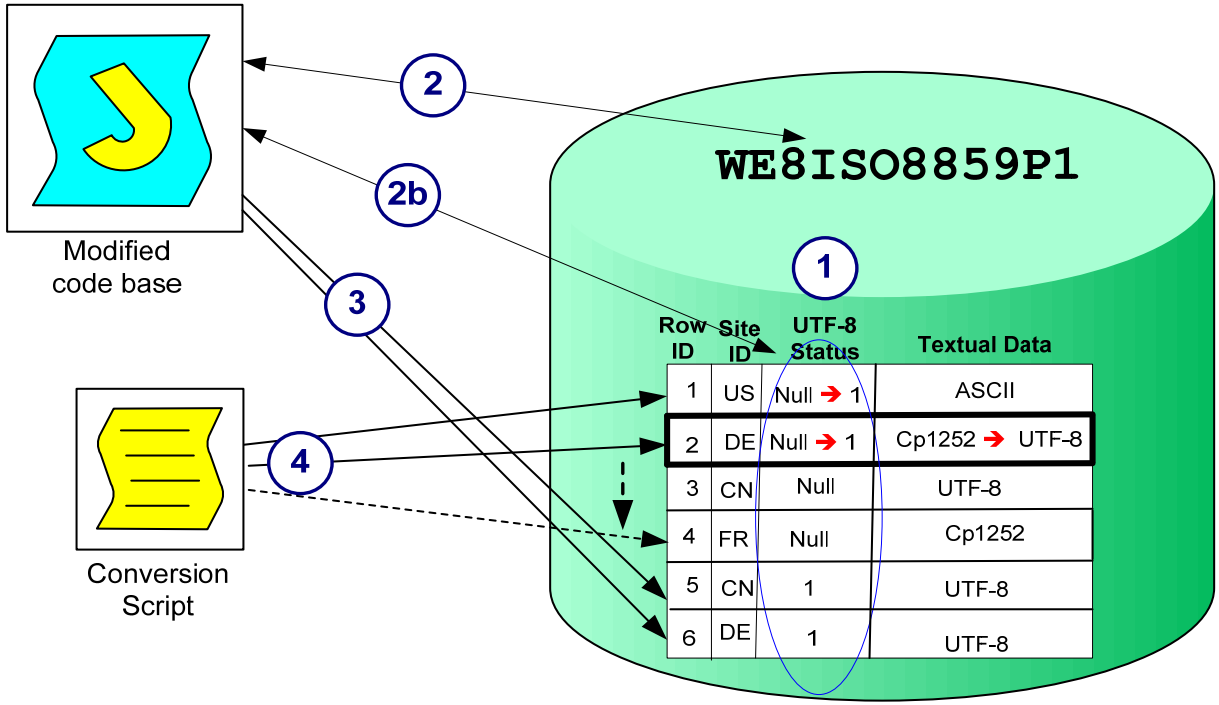
1. **Conversion with External File**
2. **Conversion with Secondary DB**
3. **In-line Conversion WITHOUT Status flag**
4. **In-line Conversion WITH Status flag**

Stages of UTF-8 DB Migration



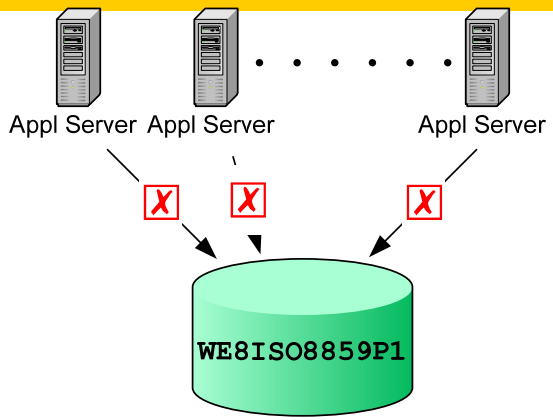
Pre Conversion and Data Conversion Stages

1. **Create a UTF-8 Status column with default value NULL in each table.**
2. **Modify code base to support UTF-8 Migration to check DB Charset**
   a. If DB is UTF-8, then use UTF-8 rules to process textual data for all sites
   b. If DB is ISO Latin 1, then process textual data according to the UTF-8 Status column
3. **Activate Implicit Conversion**
4. **Run conversion script for Explicit Conversion.**

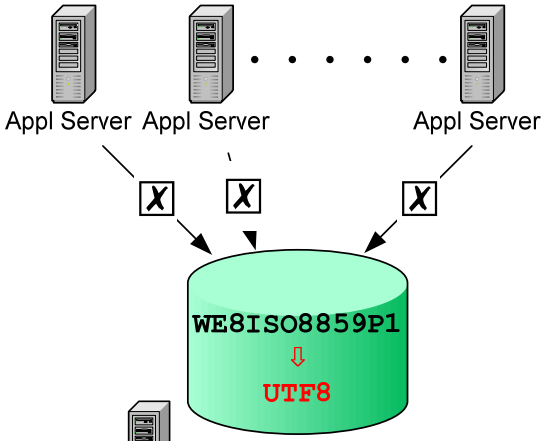


DB Migration Stage

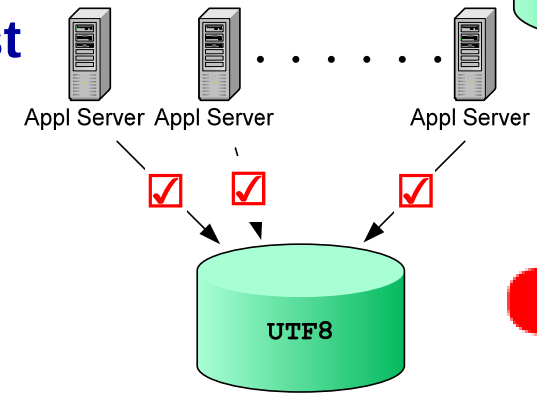
1. **Stop Incoming Traffic to DB Host**



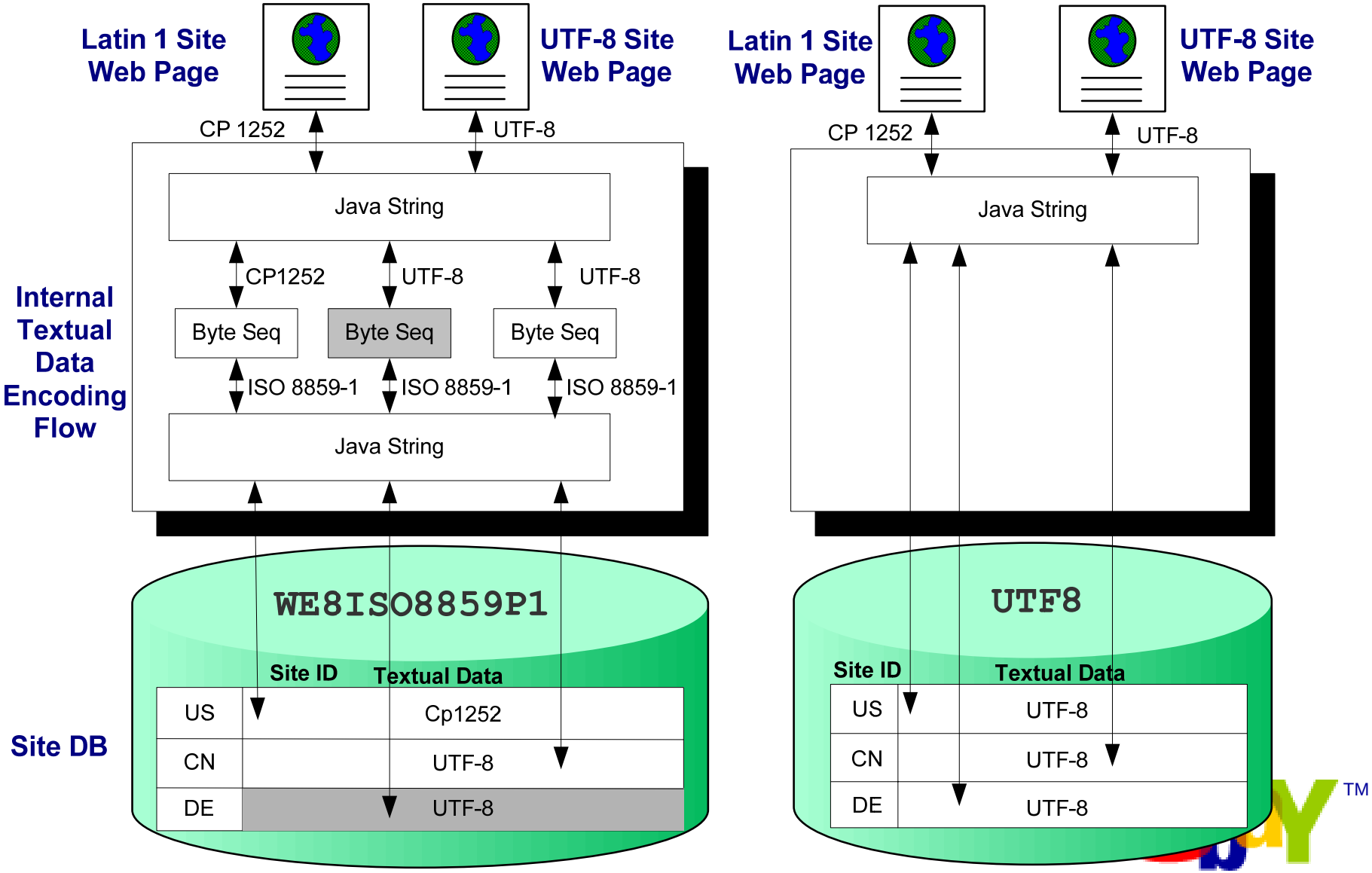
2. **ALTER DATABASE CHARSET from `WE8ISO8859P1` to `UTF8`**



3. **Restart Incoming Traffic to DB Host**



Textual Data Encoding Flow Modification



Reasons for this Approach

Pros

- **No DB downtime during data conversion. Only minimal DB outage during ALTER DB**
- **Implicit Conversion to reduce Explicit Conversion effort**
- **Ability to pause Data Conversion if necessary**
- **Ability to rollback ALTER DB if necessary**
- **Does not require additional hardware for secondary DB**

Cons

- **A new UTF-8 Status column has to be created for each table**
- **All DB access code has to be modified to handle the new UTF-8 Status column during transition period of data conversion**

Lessons Learned

Lessons Learned

- **Planning! Planning! Planning!**
  - Upfront Data Analysis
  - DB Environment Preparation
  - Leverage Site Maintenance Windows
- **Gradual Activation of Data Conversion**
- **Data Monitoring**
  - Data Environment Changes
  - Integrity of Data Conversion
  - Problematic SQL in DB Log
- **Throttle Data Conversion Speed**
- **Dedicated support resources from Development and Operations teams**

Metrics of Migration

Duration of Explicit Conversion: **~7 months**

- Number of Records: ~18 billion
- Number of Columns: ~600
- Number of Tables: ~200

Duration of DB Migration: **~7 months**

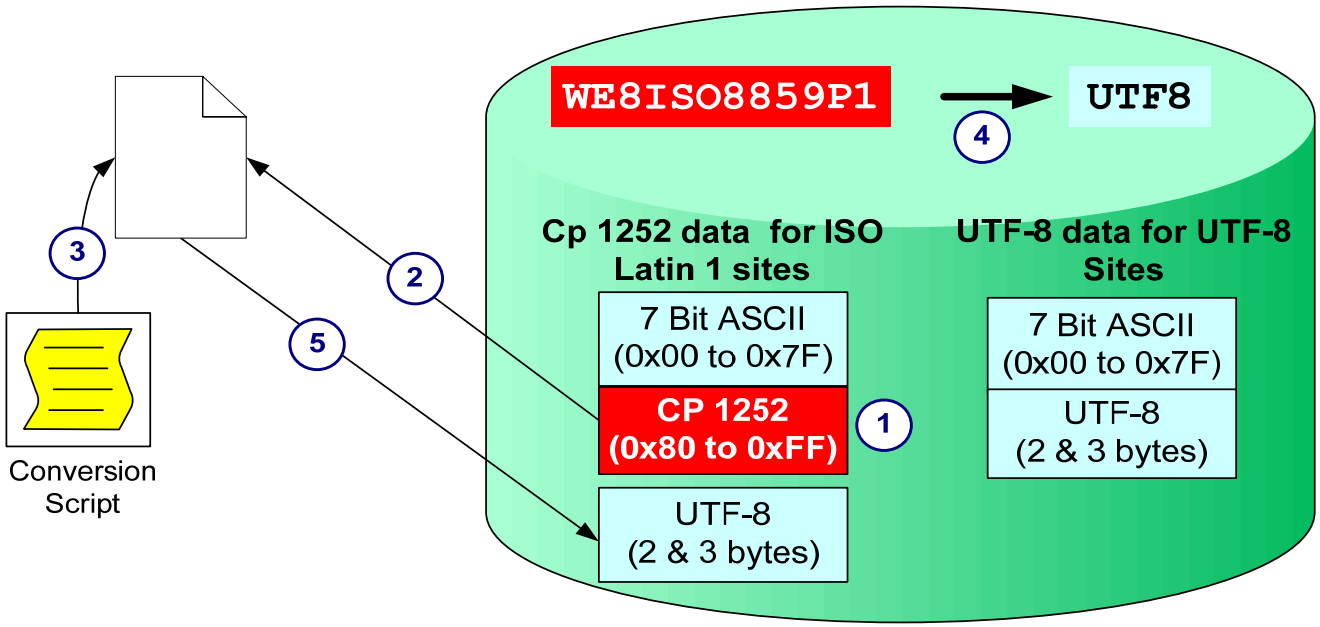
- Number of DB Host: ~100
- Site Uptime for Migration Period: > 99.94%

Q & A

Appendix

Alternative 1: Conversion with External File

1. **Identify all records with 8 bit Cp1252(0x80 to 0xFF) textual data**
2. **Extract identified records into a file**
3. **Use a script to convert the textual data in the file to UTF-8**
4. **ALTER DATABASE CHARSET from `WE8ISO8859P1` to `UTF8`**
5. **Reinsert all extracted records back into DB**



Alternative 1: Conversion with External File

Pros

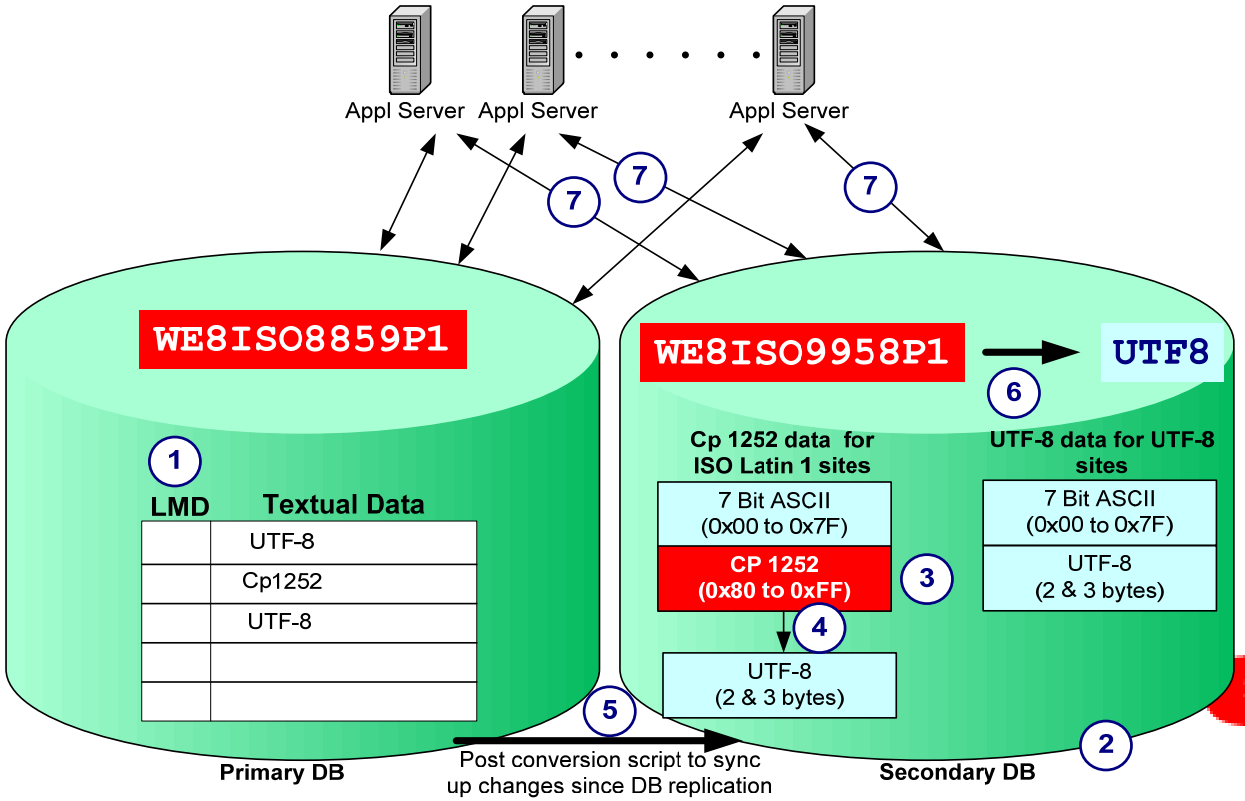
- **Avoids creating UTF-8 Status column in each table**
- **Code change to handle transition period during data migration is not required.**
- **Avoids requiring additional hardware for secondary DB**

Cons

- **Data conversion must be completed in a single outage window**
- **Prolong DB downtime due to data conversion takes place during outage window**

Alternative 2: Conversion with Secondary DB

1. **Create Last Modified Date(LMD) column in each table**
2. **Replicate Primary DB to Secondary DB and save the timestamp**
3. **In Secondary DB, identify all records with 8 bit Cp1252(0x80 to 0xFF) textual data**
4. **In Secondary DB, use a script to convert the identified records to UTF-8**
5. **In Primary DB, run post conversion script to sync up modified records since DB replication**
6. **In Secondary DB, ALTER DB CHARSET from `WE8ISO8859P1` to `UTF8`**
7. **Redirect site traffic to Secondary DB**



Alternative 2: Conversion with Secondary DB

Pros

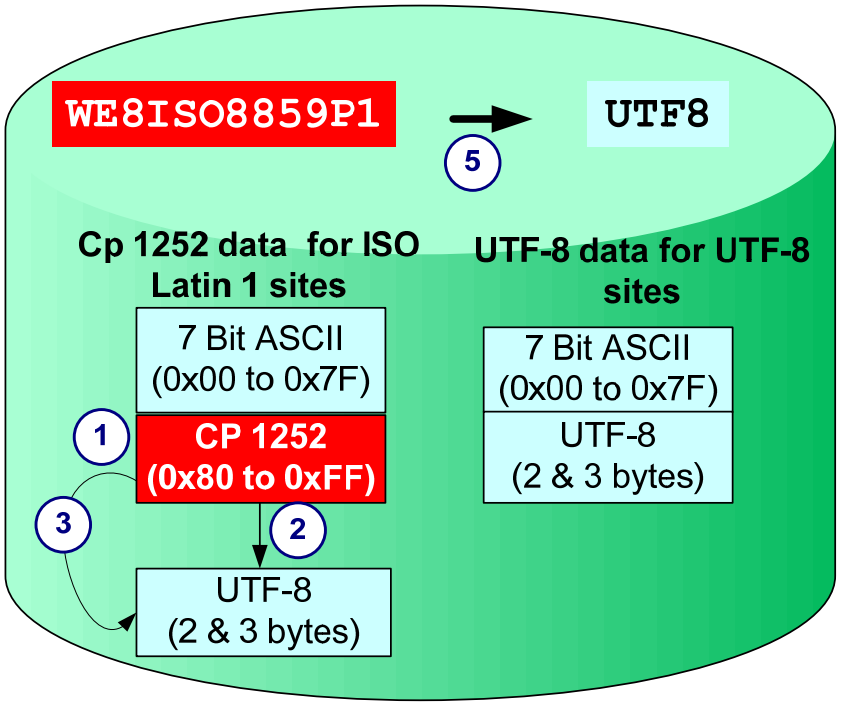
- Avoids creating UTF-8 Status column in each table
- Code change to handle transition period during data migration is not required.
- Data conversion can be restarted if necessary
- No data quality impact to source during data conversion
- No DB outage for ALTER DB. Minimal time to redirect application servers traffic

Cons

- High hardware setup and administration cost for secondary DB
- Overhead to create and maintain Last Modified Date column
- High overhead to sync up all modified records since secondary DB replication

Alternative 3: In-line Conversion WITHOUT Status column

1. **Scan to identify all records with 8 bit Cp1252(0x80 to 0xFF) textual data to be converted**
2. **Use a script to convert all identified records to UTF-8**
3. **Repeat Step 1 & 2 to convert newly generated records with Cp1252 data until there is only a small number of Cp1252 records**
4. **During DB outage window, scan for remaining records with 8 bit Cp1252 textual data and convert them to UTF-8**
5. **ALTER DATABASE CHARSET from `WE8ISO8859P1` to `UTF8`**



Alternative 3: In-line Conversion WITHOUT Status flag

Pros

- **Creation of UTF-8 Status column in each table is not required**
- **Ability to pause Data Conversion if necessary**
- **Ability to rollback ALTER DB if necessary**
- **Does not require additional hardware for secondary DB**

Cons

- **Implement charset detection logic into site code base could increase code complexity and performance overhead**
- **Charset detection to process each record is less reliable than explicit UTF-8 Status flag**
- **Multiple iteration of data conversion process**
- **Potential longer DB outage to convert remaining Cp1252 records during the final step of data conversion**